# Trends in Regionalization of Hospital Care for Common Pediatric Conditions

Urbano L. França, PhD, Michael L. McManus, MD, MPH

abstract

**OBJECTIVES:** We have previously observed that hospital care for children is concentrating significantly in Massachusetts. We now extend those observations to include 4 US states and give closer attention to the management patterns of specific clinical conditions.

**METHODS:** We used inpatient and emergency department administrative data sets from California, Florida, Massachusetts, and New York to measure transfer frequency and identify the site of care completion for >252 million hospital encounters from 2006 through 2013. We compared the concentration of pediatric care to adult care by using the Hospital Capability Index for all acute-care hospitals and quantified the regionalization of clinical conditions by using the Regionalization Index.

**RESULTS:** The availability of hospital care was significantly more limited for children than adults in all 4 states (median Hospital Capability Index: 0.19 vs 0.74 in CA, 0.08 vs 0.79 in FL, 0.18 vs 0.69 in MA, and 0.16 vs 0.75 in NY). Between 2006 and 2011, care was concentrated for both adults and children but much more so for children. Although pediatric admissions decreased by 9.3% (from 545 330 to 494 645), interhospital transfers increased by 24.6% (from 64 285 to 80 101). The largest change in transfer rate was among children with common conditions, such as abdominal pain and asthma.

**CONCLUSIONS:** Definitive pediatric hospital care is less available than adult care and is increasingly dependent on referral centers. This should be accounted for in public health plans, disaster preparedness, and determinations of network adequacy.

*Division of Critical Care, Department of Anesthesia, Perioperative and Pain Medicine, Boston Children's Hospital, Boston, Massachusetts; and Harvard Medical School, Harvard University, Boston, Massachusetts*

Drs McManus and França conceptualized and designed the study, drafted the manuscript, conducted the analyses, and reviewed and revised the manuscript; and all authors had full access to all the data in the study, take responsibility for the integrity of the data and the accuracy of the data analysis, approved the final manuscript as submitted, and agree to be accountable for all aspects of the work.

**DOI:** https://doi.org/10.1542/peds.2017-1940

Accepted for publication Sep 26, 2017

Address correspondence to Michael L. McManus, MD, MPH, Boston Children's Hospital, Bader 6th Floor, 300 Longwood Ave, Boston, MA 02115. E-mail: michael.mcmanus@childrens.harvard.edu

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).



**FINANCIAL DISCLOSURE:** The authors have indicated they have no financial relationships relevant to this article to disclose.

**FUNDING:** Supported by the Boston Children's Hospital Department of Anesthesiology, Perioperative, and Pain Medicine and the Boston Children's Hospital Endowed Chair for Critical Care Anesthesia.

**WHAT'S KNOWN ON THIS SUBJECT:** Diverse clinical reports and previous work in a single state indicate that pediatric hospital care is concentrating such that pediatric and adult care systems must be considered separately. However, the generalizability and condition-specific details of these reports are unknown.

**WHAT THIS STUDY ADDS:** On the basis of >252 million hospital encounters across 4 large US states, we confirm that definitive pediatric care has concentrated such that even common pediatric conditions are now highly regionalized.

**To cite:** França UL and McManus ML. Trends in Regionalization of Hospital Care for Common Pediatric Conditions. *Pediatrics.* 2018;141(1):e20171940





ARTICLE

Access to hospital care is critical to public health, network adequacy, and disaster preparedness. Because hospitals vary widely in size, complexity, and capability, interfacility transfer practices have arisen to match patients to the services they require. When transfer partners are readily available, hospitals may freely increase or decrease services according to their competitive environments. Over time, small and unprofitable services may close and care becomes concentrated within a few referral centers. A growing number of clinical reports suggest that this dynamic is now operating strongly in pediatric care.[1–5]

We have previously shown that pediatric hospital care in Massachusetts has concentrated markedly over the past decade.[6] As a result, the interfacility transfer of children is common, and there is increasing reliance on a small number of major referral centers. In that state, patterns of pediatric and adult hospital care now differ so widely that the systems are best considered separately by regulators and public health planners.

Massachusetts differs from other American states in many ways, including its high rates of insurance coverage, its historically unique regulatory environment, and its dominance by large, academic medical centers. Therefore, it is possible that hospital care in Massachusetts is not representative of care elsewhere in the country and conclusions regarding its pediatric care are not generalizable. To investigate this further, we undertook a larger, multiyear, comparative study of pediatric and adult hospital care in 4 US states and gave closer attention to the transfer and management patterns of specific clinical conditions.

## METHODS

### Data Source

We analyzed the most recent overlapping years available of administrative data sets from 2 different sources: the state inpatient and emergency department (ED) data sets of the Healthcare Cost and Utilization Project (HCUP)[7] for California (2006–2011), Florida, and New York (2006–2013) and the 2006–2013 inpatient, observation admission, and ED Acute Hospital Case Mix data sets from the Massachusetts Center for Health Information and Analysis (CHIA).[8] The CHIA and HCUP data sets are similar and together included demographic and clinical information concerning >252 million patient encounters. Our proposed use of these data were reviewed and approved by the CHIA Data Release Committee. Data use approval and a waiver of informed consent were also obtained from the Boston Children's Hospital Committee on Clinical Investigation.

### Hospitals and Population

To define each state's acute-care hospital system, we followed the same procedures described previously[6,9] and analyzed all hospitals that maintained active EDs and admitted patients for general medical or surgical conditions. Patients were classified as pediatric (<18 years old) or adult (≥18 years old), and the principal diagnosis of each hospital encounter was mapped into 1 of the 285 Clinical Classifications Software (CCS) codes[10] provided by HCUP. Patients who were treated in and discharged from the ED were considered outpatients. Those who required admission and/or services at >1 hospital were treated as inpatients, and their care was considered complete on discharge to home or a chronic care facility. We excluded from our analysis (1) mental health conditions (CCS codes 650–670), (2) well newborns (*International Classification of Diseases, Ninth Revision, Clinical Modification* codes V30–V39), (3) adult patients in the CHIA ED for whom the transfer could not be matched to a posterior admission, and (4) rare conditions seen <20 times per year statewide. Transfer rates (TRs) per 1000 encounters were calculated as the number of patients transferred statewide divided by the number of patients requiring admission or transfer.

### Hospital Capability and Regionalization Indices

We have previously constructed and applied indices of hospital activity and care regionalization based on TRs and the ultimate site of care completion.[6,9] As described briefly below and in detail elsewhere,[9] we calculated these indices for all patients and all conditions within the acute-care hospital system of each state. Each index can be further stratified by condition, hospital system, patient demographics, insurance status, or other variables according to questions of interest.

The Hospital Capability Index (HCI), which focuses on patients who require admission or care in >1 hospital, quantifies a hospital's or hospital system's average completion of care across all the CCS conditions encountered in a state over a given period. It provides information concerning the range of conditions that are routinely cared for to completion in that hospital or system. Hospitals with HCIs close to 1 serve a broad range of conditions and rarely transfer patients for additional care. Hospitals with lower HCIs care for a narrower range of conditions and/or frequently transfer patients for care. By definition, HCI is a measure of how a hospital is currently functioning to definitively complete the care of all types of conditions. It is not a measure of existing resources, quality, or potential capability under different circumstances.

Similarly, the likelihood of care completion at all hospitals within a system allows for the definition of the Regionalization Index (RI), which quantifies the degree to which the care of a specific condition is regionalized. The RI of a condition takes into account both transfers for care and self-referrals, so it can be understood as simultaneously reflecting both the fraction of patients who are transferred and the fraction of hospitals that no longer encounter a condition. Conditions commonly transferred or seen in only a few hospitals will have RIs close to 1, whereas conditions for which the care is completed in most hospitals with a low frequency of transfer will have RIs closer to 0.

## Analysis by Payer

When possible, we compared TRs among public and privately insured children. Because of changes in the reporting of Medicaid managed care patients seen at EDs in the New York HCUP data in 2010, we excluded New York from the comparisons between years and in the analysis of trends involving insurance status.

## Statistical Analysis

We report descriptive and summary statistics for the RIs and HCIs across 4 states over multiple years. Spearman rank correlation is used to compare RIs between and among states. Trends of admissions, transfers, TRs, HCIs, and RIs were assessed by using the Mann-Kendall trend test. Comparison between pediatric and adult cohorts used the Wilcoxon signed-rank test. All analyses used Python 3.5, an open-source programming language, and the Jupyter Notebook environment.[11]

# RESULTS

The complete data for California, Florida, Massachusetts, and New York encompass 252 439 113 ED and inpatient encounters, of which 55 883 403 were pediatric. Our final data set contained ~59 million encounters that resulted in admission (*n* = 55 789 553) or transfer (*n* = 3 118 371). Children accounted for 3 699 124 (6.6%) admissions and 536 544 (17.2%) transfers. The number of pediatric transfers increased steadily in all states, whereas both the number of pediatric admissions (Table 1) and the number of hospitals caring for children declined. From 2006 through 2011, pediatric admissions decreased by 9.3% (from 545 330 to 494 645; *P* = .02), whereas interhospital transfers increased by 24.6% (from 64 285 to 80 101; *P* < .01). During the same period, adult admissions remained constant, varying by <0.3% (from 7 168 939 to 7 152 830; *P* = .999), whereas transfers increased by 24.8% (from 314 612 to 392 675; *P* < .01). As compared with 2006, 24 fewer California hospitals admitted 10 or more children in 2011 (−8%; from 296 to 272), and in 2013, 20 fewer hospitals admitted children in Florida (−14%; from 146 to 126), 7 fewer hospitals admitted children in Massachusetts (−12%; from 59 to 52), and 29 fewer hospitals admitted children in New York (−17%; 166 to 137). In comparison, for the same periods, the number of hospitals serving adults decreased by 2% (from 322 to 314) in California, 6% (from 184 to 173) in New York, remained unchanged in Massachusetts (*n* = 66), and increased by 2% (from 180 to 184) in Florida.

**TABLE 1** Number of Transfers and Admissions at the Beginning and End of Study Periods

| | No. Transfers 2006 | No. Admissions 2006 | No. Transfers Last Year | No. Admissions Last Year |
|---|---|---|---|---|
| Pediatric | | | | |
| CA (2006–2011) | 30 896 | 224 237 | 33 590 | 202 141 |
| FL (2006–2013) | 13 120 | 129 208 | 21 570 | 112 737 |
| MA (2006–2013) | 9603 | 51 142 | 11 326 | 47 612 |
| NY (2006–2013) | 10 666 | 140 743 | 14 761 | 110 541 |
| Adult | | | | |
| CA (2006–2011) | 141 097 | 2 653 346 | 161 291 | 2 601 210 |
| FL (2006–2013) | 59 151 | 1 937 133 | 78 292 | 1 984 455 |
| MA (2006–2013) | 48 329 | 728 331 | 60 761 | 752 533 |
| NY (2006–2013) | 66 035 | 1 850 129 | 82 793 | 1 653 887 |

CA, California; FL, Florida; MA, Massachusetts; NY, New York.

## Pediatric Versus Adult HCI

Overall, hospitals in every state differed greatly in the scope of adult and pediatric conditions they treated. Figure 1 compares hospital capability distributions for pediatric and adult care in 2011, the most recent year for which data from all 4 states are available. All states show a similar pattern, with most acute-care hospitals demonstrating a high capability for adult care and few hospitals demonstrating a high capability for pediatric care. The median hospital capability for pediatric care (pediatric HCI) was significantly lower than for adult care in all 4 states (CA: 0.19 [interquartile range (IQR): 0.09–0.36] vs 0.74 [IQR: 0.57–0.86]; FL: 0.08 [IQR: 0.02–0.22] vs 0.79 [IQR: 0.66–0.87]; MA: 0.18 [IQR: 0.06–0.30] vs 0.74 [IQR: 0.62–0.84]; NY: 0.16 [IQR: 0.06–0.37] vs 0.75 [IQR: 0.59–0.86]; *P* < .01).

The scope of the pediatric conditions treated declined, on average, over all periods in all states. Figure 2 shows the relative change in pediatric HCI in all 4 states since 2006. Although there was a modest (4.3% on average) decrease in the mean adult HCIs (*P* < .01), pediatric capability declined an average of 12.8% in California from 2006 to 2011 (*P* = .02), 23.8% in Florida

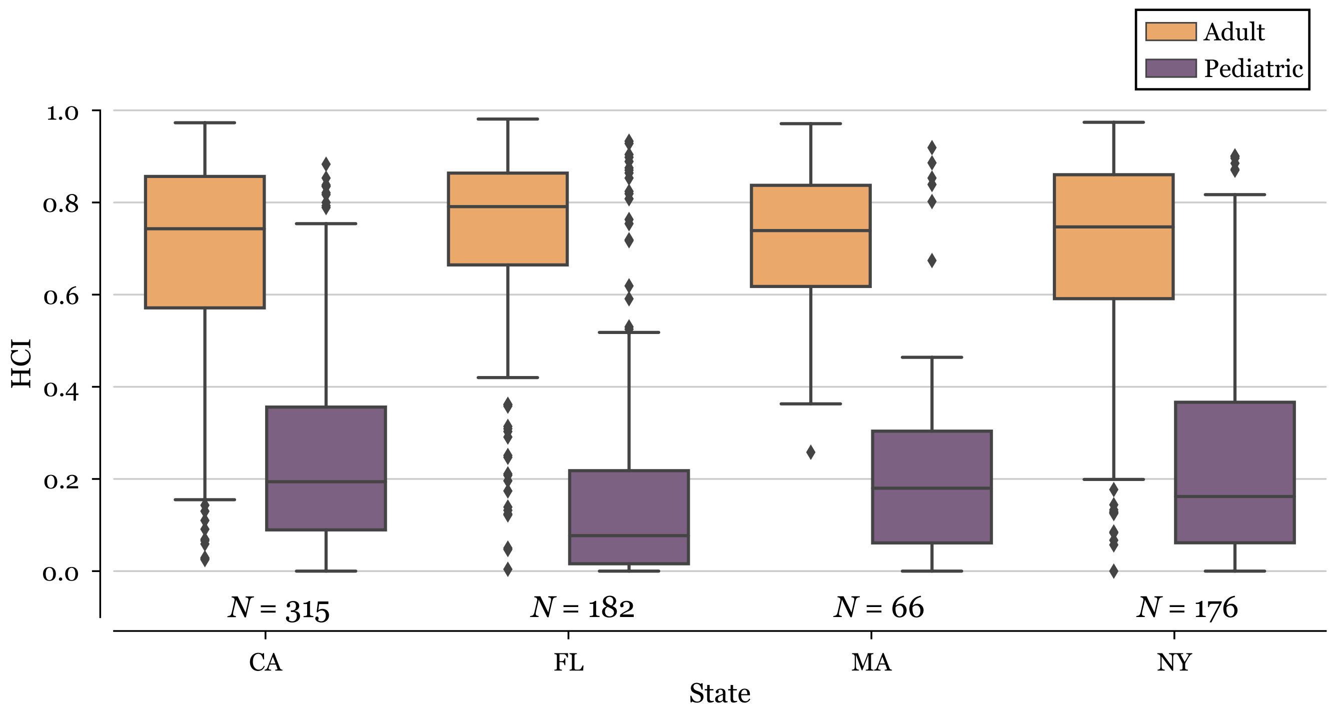


**FIGURE 1**
HCIs of the hospitals in a system for the different cohorts and states in 2011. CA, California; FL, Florida; MA, Massachusetts; NY, New York.

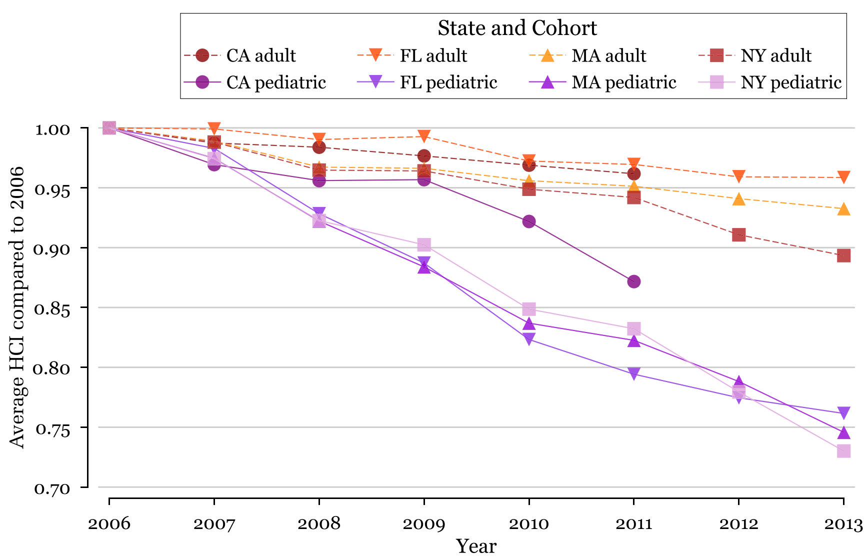


**FIGURE 2**
Average HCIs relative to 2006 for different patient cohorts and states. CA, California; FL, Florida; MA, Massachusetts; NY, New York.

from 2006 to 2013, 27.0% in New York, and 25.4% in Massachusetts during the same period ($P < .01$ for 2006–2013). Overall, the average year-over-year decline in HCI for care of pediatric conditions was 4% and of adult conditions was 1%. Again, it is noteworthy that all trends for both pediatric and adult capability indices were similar across all 4 states.

## Pediatric Regionalization

As a corollary of the above, patterns of regionalization were also similar across the 4 states. The median RI for all pediatric conditions in 2011 was 0.80 (IQR: 0.65–0.91) in California, 0.84 (IQR: 0.77–0.91) in Florida, 0.82 (IQR: 0.70–0.89) in Massachusetts, and 0.77 (IQR: 0.66–0.89) in New York. When conditions are compared between 2006 and 2011, the regionalization of all pediatric hospital care increased by 6.3% in California, 7.7% in Florida, 8.8% in Massachusetts, and 9.8% in New York ($P < .01$). Figure 3 presents marginal and joint distributions of pediatric RIs for all 173 pediatric CCS conditions present in all states in 2011. The high linearity reveals that all conditions were similarly regionalized in all states. Overall, there were no significant differences among RIs for the CCS conditions present in all states in 2006 and 2011 (Spearman's rank correlation, $r > 0.90$ and $P < .01$ for all possible combinations of states in both years).

As expected, complex pediatric conditions returned high RIs in all states over all the years of study. For example, RIs for pediatric cerebrovascular disease and chronic renal disease averaged 0.95, valvular

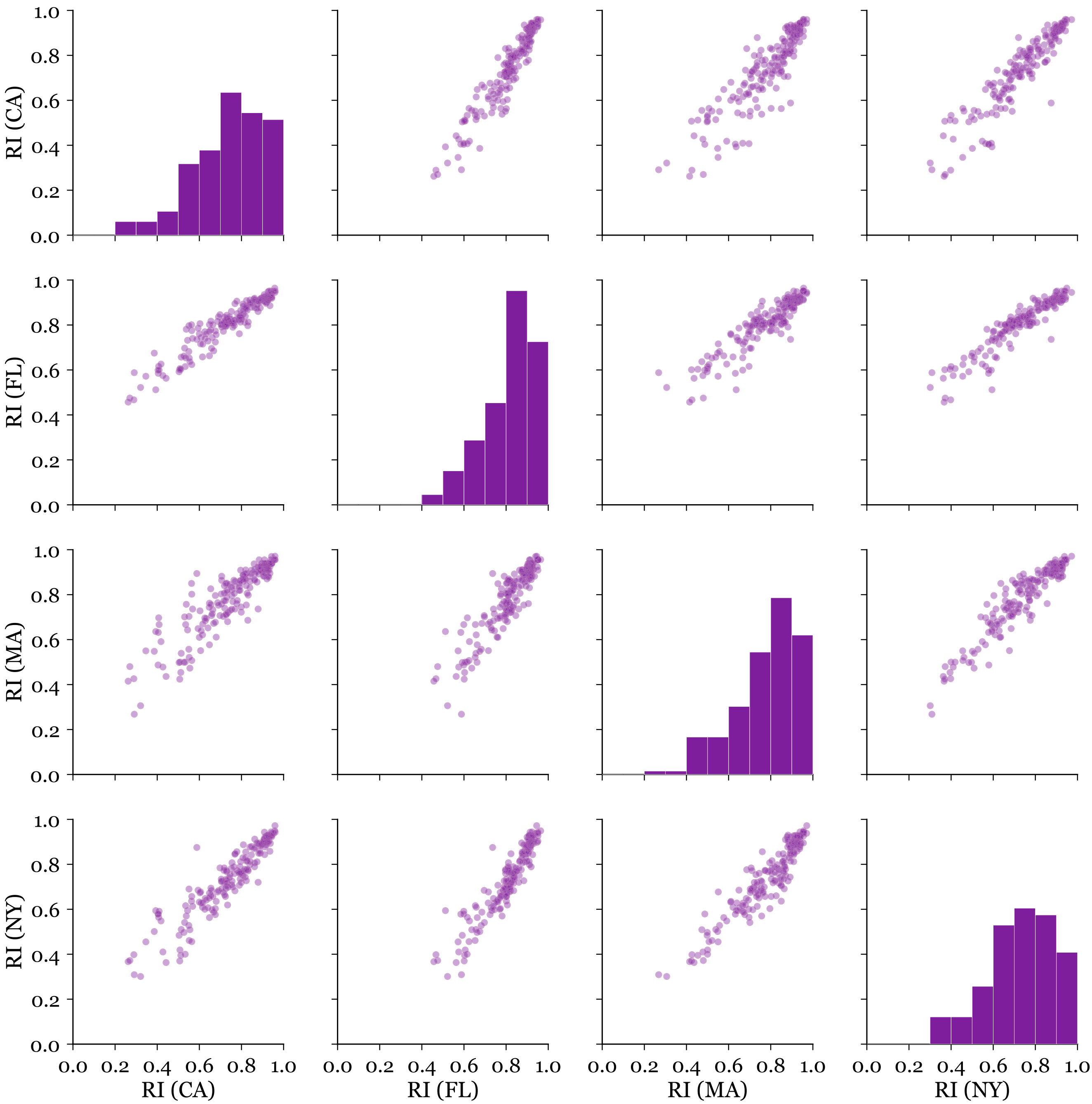


**FIGURE 3**

Comparison of RIs for all the pediatric CCS conditions present in 4 states in 2011. Rows contain each state's RI distribution frequency along with comparison scatterplots of RIs for every condition. Linear relationships indicate that all CCS conditions are similarly regionalized. CA, California; FL, Florida; MA, Massachusetts; NY, New York.

heart disease and cancer averaged 0.94, and cystic fibrosis averaged 0.92. Moderately regionalized conditions, such as biliary tract disease, returned RIs close to 0.4, with modest increases from 2006 to 2011. No condition decreased in regionalization across all states, and many common conditions, such as hemolytic jaundice, appendicitis, and urinary tract infections (average RIs of 0.25–0.35 in 2006) showed substantial increases. Table 2 presents the regionalization patterns for the 10 conditions that exhibited the greatest RI change from 2006 to 2011 when averaged over all states. They include appendicitis (70.6%), gastroenteritis (46.2%), skin infections (40.3%), asthma (29.4%), leg fracture (28.6%), and tonsillitis (25.8%). Steady, nearly parallel increases were seen in all states, and Fig 4 presents 7 years

**TABLE 2** Ten Conditions With the Largest RI Change From 2006 to 2011

| Condition | CA | | FL | | MA | | NY | | Average (% Change) |
|---|---|---|---|---|---|---|---|---|---|
| | RI 2011 (% Change) | TR | RI 2011 (% Change) | TR | RI 2011 (% Change) | TR | RI 2011 (% Change) | TR | |
| Appendicitis and other appendiceal conditions | 0.29 (35.7) | 98 | 0.59 (74.3) | 212 | 0.27 (92.8) | 109 | 0.31 (80.7) | 83 | 70.6 |
| Noninfectious gastroenteritis | 0.50 (26.4) | 95 | 0.59 (28.6) | 100 | 0.50 (61.7) | 67 | 0.48 (68.1) | 84 | 46.2 |
| Skin and subcutaneous tissue infections | 0.43 (29.1) | 117 | 0.58 (47.4) | 102 | 0.48 (29.2) | 100 | 0.41 (55.9) | 71 | 40.3 |
| Abdominal pain | 0.63 (16.4) | 487 | 0.77 (17.5) | 563 | 0.70 (30.1) | 463 | 0.60 (53.4) | 430 | 29.4 |
| Asthma | 0.51 (28.5) | 133 | 0.60 (31.5) | 101 | 0.45 (16.7) | 86 | 0.40 (40.6) | 49 | 29.4 |
| Fracture of lower limb | 0.53 (16.5) | 195 | 0.70 (29.3) | 240 | 0.70 (29.8) | 361 | 0.54 (39.4) | 179 | 28.6 |
| Urinary tract infections | 0.44 (26.8) | 96 | 0.57 (26.6) | 72 | 0.44 (16.6) | 59 | 0.36 (34.9) | 41 | 26.2 |
| Acute and chronic tonsillitis | 0.55 (27.4) | 60 | 0.64 (14.9) | 75 | 0.47 (27.2) | 15 | 0.51 (34.3) | 44 | 25.8 |
| Fracture of upper limb | 0.57 (21.2) | 231 | 0.74 (22.7) | 407 | 0.74 (18.7) | 437 | 0.61 (40.0) | 294 | 25.6 |
| Fluid and electrolyte disorders | 0.51 (21.1) | 103 | 0.60 (22.6) | 93 | 0.42 (23.3) | 40 | 0.37 (33.6) | 35 | 25.1 |

Conditions with high RIs are definitively managed in a few institutions and are frequently transferred. Conditions with low RIs are cared for in many places and infrequently transferred. Because the RI simultaneously captures self-selection and transfer (given 1000 TRs are also provided), they are calculated as the no. patients transferred statewide and divided by the no. patients requiring admission or transfer. For example, in California in 2011, 95 of 1000 children who presented to a hospital with gastroenteritis and were not discharged from the hospital were transferred to another institution. CA, California; FL, Florida; MA, Massachusetts; NY, New York.

of experience in New York as an example. In practical terms, these common conditions accounted for 14 550 pediatric transfers in 2006 and 19 765 in 2011 (a change of 35.8%). Approximately half of all admitted children were insured by Medicaid, and this fraction increased in each state over the periods for which data were available. In California, 50.4% of all those admitted to pediatric hospitals (*n* = 113 113) were insured by Medicaid in 2006, and this fraction increased to 52.9% (*n* = 106 967) in 2011. In Florida, 53.3% of admissions in 2006 (*n* = 68 938) and 63.9% of those admitted in 2013 (*n* = 72 060) had Medicaid, whereas in New York, the Medicaid fraction rose from 48.7% (*n* = 68 506) to 56.5% (*n* = 62 429). The largest increase was observed in Massachusetts, from 28.4% (*n* = 14 563) in 2006 to 41.5% (*n* = 19 765) in 2013.

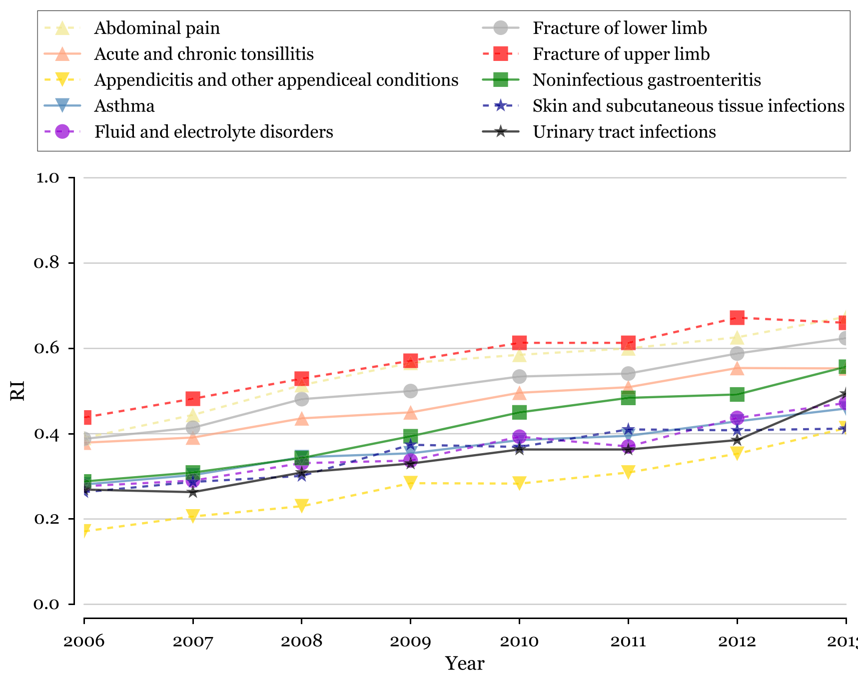


**FIGURE 4**
RI trends in New York for the 10 conditions with the greatest 4-state average change.

Meanwhile, the rate of transfers followed general population trends, increasing steadily among both publicly and privately insured children. In aggregate across all states, TRs increased among both Medicaid and privately insured pediatric patients. Rates for the former rose from 101 per 1000 encounters in 2006 to 143 per 1000 in 2011, whereas the latter increased from 124 per 1000 encounters to 152 per 1000 ($P < .02$). In California, Medicaid patients constituted 47.2% of all transfers in 2011. In 2013, 64.5% of all those who were transferred in Florida had Medicaid compared with 52.4% in New York and 47.1% in Massachusetts.

## DISCUSSION

This work extends our previous observation that options for pediatric hospital care are decreasing. Here, we report a similar pattern of care concentration in 4 states that together comprise approximately one-quarter of the US population. Although most hospitals continued to care for adults with a wide range of conditions, we observed a steady decrease in the average scope of the pediatric care they offered and an increasing dependence on referral centers. Within all 4 states, there were similar overall and condition-specific patterns of pediatric care regionalization. The largest changes in regionalization occurred in the care of common conditions, such as abdominal pain, asthma, limb fractures, and gastroenteritis. To some degree, this was due to a decrease in the number of hospitals admitting children, but TRs also increased among hospitals that continued to admit children. Because the availability of definitive pediatric hospital care differs widely from adult care, we believe that this should be taken into consideration during disaster planning and determinations of network adequacy.

This study adds to a growing literature suggesting that pediatric hospital care is under pressure. For some time, pediatric emergency physicians in academic centers have reported seeing an increasing number of children who are referred with minor conditions.[1,2,12,13] At the same time, pediatric surgical specialists have described a gradual migration of low-risk, high-volume procedures into tertiary centers.[3–5,14] Our initial analysis of the entire Massachusetts acute-care hospital system showed a significant shift of all types of pediatric hospital care from community facilities to academic centers.[6] This report confirms that care is also concentrating in much larger states.

The precise reasons for care concentration remain to be determined. A decrease in overall demand is suggested by Agency for Healthcare Research and Quality reports that national pediatric hospital discharges declined by ~10% (from 6.47 million to 5.85 million) from 2003 to 2012.[15] Therefore, it is possible that regionalization reflects the closure of services with marginal volume. A decrease in profitability is also suggested by our observation that Medicaid covers an increasing fraction of admitted children as well as national reports that Medicaid coverage is higher among children than adults.[15] Finally, decades of medical success have led to a growing number of children with complex conditions, many of whom may now require care in specialized centers.[16,17] Although simple, common conditions accounted for the most transfers and showed the greatest change in regionalization, we did not attempt to control for comorbidities.

The short- and long-term impacts of care concentration also remain to be seen. Certainly, regionalization of care can yield economies of scale and improvements in quality as children are increasingly cared for by pediatric specialists in pediatric settings. However, the transfer of patients from low-volume to high-volume centers may improve outcomes for some conditions[18,19] but worsen them for others.[20] Regionalization may also bring economies of scale and decreased cost under some circumstances but waste and unnecessary expense under others.[13,21,22] Although quality can be improved when children with complex conditions are efficiently conducted to specialists, it may decline if common conditions crowd specialty centers[23–28] and if core competency is lost in firstline rural or community hospitals.[2,29] In addition, lost capacity today can be problematic in the future if US Census Bureau projections of an increasing pediatric population prove correct.[30]

Regardless of the drivers and consequences of care concentration, it is clear that hospitals now differ widely in their delivery of pediatric care.[6,9] This being so, network experience from adult populations, such as Medicare, is not transferrable. Therefore, all Accountable Care Organizations and hospital networks should be specifically analyzed to ensure that they meet the needs of children. Because roughly half of all hospitalized children receive public insurance, Medicaid network adequacy should be particularly scrutinized. Here, we observed no large differences in the number of transfers between publically and privately insured children, but we did not evaluate differential regionalization by condition or differential capabilities of individual hospitals. However, earlier work in Massachusetts showed the greatest loss of pediatric capability among community-disproportionate share hospitals.[6]

Similarly, the differential capabilities of hospitals with respect to pediatric care should be an important part of disaster planning. Although HCI does not measure physical resources or core competency, it does reflect institutional familiarity with pediatric care. Because hospitals with low pediatric HCIs may perform unevenly in caring for children, crisis standards of care should be formulated accordingly.[31]

This analysis is limited in several ways. First, it relies on large volumes of administrative data and, as such, is subject to errors in data processing, variability in coding, and disagreements with clinical registries.[32] Here, we used CCS grouper codes to reduce some of the errors inherent in the Ninth or 10th revisions of the *International Classification of Diseases* coding and analyzed each state separately to avoid data processing errors. Second, as noted above, we did not give attention to comorbidities, which may have driven some transfer decisions. Although such work is necessary to identify the drivers of regionalization, the degree of regionalization remains unchanged. Third, a complete analysis of care would include mental health conditions, but we excluded these because that care lies predominately outside the system of acute-care hospitals. Fourth, although the states studied here contain both urban and rural populations, they are large and predominantly urban. Although findings here may differ from less populated, more rural states, potentially avoidable pediatric interhospital transfer has been reported in Iowa,[13] and rural residence has been identified as an independent predictor of transfer within a nationally representative sample of admissions.[33] Finally, we elected to study hospital systems at the state level, although a more granular geographical view would likely offer additional insights.

## CONCLUSIONS

We expanded and confirmed our previous analysis showing that adult and pediatric hospital care are differentially regionalized. As compared with adult care, pediatric hospital care is becoming increasingly concentrated and dependent on referral centers. This is true even for common pediatric conditions, such as abdominal pain, asthma, and fractures. These differences should be accounted for by health planners and regulators in public health initiatives, disaster planning, and determinations of network adequacy.

## ABBREVIATIONS

CCS: Clinical Classifications Software
CHIA: Center for Health Information and Analysis
ED: emergency department
HCI: Hospital Capability Index
HCUP: Healthcare Cost and Utilization Project
IQR: interquartile range
RI: Regionalization Index
TR: transfer rate

**POTENTIAL CONFLICT OF INTEREST:** The authors have indicated they have no potential conflicts of interest to disclose.

## REFERENCES


1. Li J, Monuteaux MC, Bachur RG. Interfacility transfers of noncritically ill children to academic pediatric emergency departments. *Pediatrics*. 2012;130(1):83–92
2. Gattu RK, Teshome G, Cai L, Wright C, Lichenstein R. Interhospital pediatric patient transfers-factors influencing rapid disposition after transfer. *Pediatr Emerg Care*. 2014;30(1):26–30
3. Salazar JH, Goldstein SD, Yang J, et al. Regionalization of pediatric surgery: trends already underway. *Ann Surg*. 2016;263(6):1062–1066
4. Shay S, Shapiro NL, Bhattacharyya N. Patterns of hospital use and regionalization of inpatient pediatric adenotonsillectomy. *JAMA Otolaryngol Head Neck Surg*. 2016;142(2):122–126
5. Hsu EY, Schwend RM, Julia L. How many referrals to a pediatric orthopaedic hospital specialty clinic are primary care problems? *J Pediatr Orthop*. 2012;32(7):732–736
6. França UL, McManus ML. Availability of definitive hospital care for children. *JAMA Pediatr*. 2017;171(9):e171096
7. Healthcare Cost and Utilization Project. State-specific HCUP databases. Available at: https://www.hcup-us.ahrq.gov/databases.jsp. Accessed June 7, 2017
8. Massachusetts Center for Health Information and Analysis. Available at: http://www.chiamass.gov/chia-data/. Accessed June 7, 2017
9. França UL, McManus ML. Transfer frequency as a measure of hospital capability and regionalization. *Health Serv Res*. 2017;52(6):2237–2255
10. Healthcare Cost and Utilization Project. Clinical Classifications Software (CCS) for ICD-9-CM, 2006–2009. 2013. Available at: https://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp. Accessed June 7, 2017
11. Perez F, Granger BE. IPython: a system for interactive scientific computing. *Comput Sci Eng*. 2007;9(3):21–29
12. Peebles ER, Miller MR, Lynch TP, Tijssen JA. Factors associated with discharge home after transfer to a pediatric emergency department [published online ahead of print March 21, 2017]. *Pediatr Emerg Care*.doi:10.1097/PEC.0000000000001098
13. Mohr NM, Harland KK, Shane DM, Miller SL, Torner JC. Potentially avoidable pediatric interfacility transfer is a costly burden for rural families: a cohort study. *Acad Emerg Med*. 2016;23(8):885–894
14. Salazar JH, Goldstein SD, Yang J, et al. Regionalization of the surgical care of children: a risk-adjusted comparison of hospital surgical outcomes by geographic areas. *Surgery*. 2014;156(2):467–474
15. Witt WP, Weiss AJ, Elixhauser A. *Overview of Hospital Stays for Children in the United States, 2012: Statistical Brief #187*. Rockville, MD: Agency for Healthcare Research and Quality; 2006
16. Berry JG, Hall M, Neff J, et al. Children with medical complexity and Medicaid: spending and cost savings. *Health Aff (Millwood)*. 2014;33(12):2199–2206
17. Berry JG, Hall M, Hall DE, et al. Inpatient growth and resource use in 28 children's hospitals: a longitudinal, multi-institutional study. *JAMA Pediatr*. 2013;167(2):170–177
18. Gupta P, Rettiganti M, Fisher PL, Chang AC, Rice TB, Wetzel RC. Association of freestanding children's hospitals with outcomes in children with critical illness. *Crit Care Med*. 2016;44(12):2131–2138
19. Burke LG, Frakt AB, Khullar D, Orav EJ, Jha AK. Association between teaching

status and mortality in US hospitals. *JAMA*. 2017;317(20):2105–2113

20. Faine BA, Noack JM, Wong T, et al. Interhospital transfer delays appropriate treatment for patients with severe sepsis and septic shock: a retrospective cohort study. *Crit Care Med*. 2015;43(12):2589–2596

21. Menke TJ, Wray NP. When does regionalization of expensive medical care save money? *Health Serv Manage Res*. 2001;14(2):116–124

22. Bertazzoni G, Cristofani M, Ponzanetti A, et al. Scant justification for interhospital transfers: a cause of reduced efficiency in the emergency department. *Emerg Med J*. 2008;25(9):558–561

23. McManus ML, Long MC, Cooper A, et al. Variability in surgical caseload and access to intensive care services. *Anesthesiology*. 2003;98(6):1491–1496

24. Burkle FM Jr. Pediatric reverse triage-uncomfortable but real decision making for community preparedness. *JAMA Pediatr*. 2017;171(4):e164839

25. Kelen GD, Troncoso R, Trebach J, et al. Effect of reverse triage on creation of surge capacity in a pediatric hospital. *JAMA Pediatr*. 2017;171(4):e164829

26. Depinet HE, Iyer SB, Hornung R, Timm NL, Byczkowski TL. The effect of emergency department crowding on reassessment of children with critically abnormal vital signs. *Acad Emerg Med*. 2014;21(10):1116–1120

27. Fieldston ES, Hall M, Sills MR, et al. Children's hospitals do not acutely respond to high occupancy. *Pediatrics*. 2010;125(5):974–981

28. Fieldston E, Ragavan M, Jayaraman B, Metlay J, Pati S. Traditional measures of hospital utilization may not accurately reflect dynamic patient demand: findings from a children's hospital. *Hosp Pediatr*. 2012;2(1):10–18

29. Dharmar M, Marcin JP, Romano PS, et al. Quality of care of children in the emergency department: association with hospital setting and physician training. *J Pediatr*. 2008;153(6):783–789

30. US Census Bureau. National population projections: Summary tables. 2014. Available at: https://www.census.gov/data/tables/2014/demo/popproj/2014-summary-tables.html. Accessed June 7, 2017

31. Stroud C, Hick JL, Hanfling D; Institute of Medicine. *Crisis Standards of Care: A Toolkit for Indicators and Triggers*. Washington, DC: National Academies Press; 2013

32. Lawson EH, Louie R, Zingmond DS, et al. Using both clinical registry and administrative claims data to measure risk-adjusted surgical outcomes. *Ann Surg*. 2016;263(1):50–57

33. Rosenthal JL, Hilton JF, Teufel RJ II, Romano PS, Kaiser SV, Okumura MJ. Profiling interfacility transfers for hospitalized pediatric patients. *Hosp Pediatr*. 2016;6(6):345–353

PEDIATRICS®
OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

**Trends in Regionalization of Hospital Care for Common Pediatric Conditions**

Urbano L. França and Michael L. McManus

*Pediatrics* 2018;141;
DOI: 10.1542/peds.2017-1940 originally published online December 20, 2017;